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Cold, Clouds, and Snowflakes

Purpose: To use satellite data to explore the relationship between the amount of water vapor and the temperature of clouds, as well as snowflake shapes and cloud temperature

Image courtesy USDA

Grade Level: 4 – 7

Estimated Time for Completing Activity: 90 minutes

Learning Outcomes:
1 Students will locate and use NASA satellite data to create graphs.
2 Students will draw conclusions from maps and graphs.
3 Students will use formulas to convert measurements.
4 Students will determine the latitude and longitude from a map location.

Prerequisite
1 Familiarity with the use of latitude and longitude
2 Previous practice with evaluating mathematical expressions
3 Previous knowledge in states of matter (solid, liquid, gas)
4 Overview of Winter Precipitation Types

Tools
1 Computer with Internet access
2 Map or Altas
3 Microsoft Word or other word processing software

National Standards:
1 **Geography:** The World in Spatial Terms
2 **Science Content:** A Science as Inquiry
3 **Science Content:** D Earth and Space Science
4 **Math:** Data Analysis and Probability
5 **Math:** Number and Operations

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http://mynasadata.larc.nasa.gov/?page_id=474?&passid=96

Virginia Standards of Learning:

1 **ES.1c:** The student will plan and conduct investigations in which scales, diagrams, maps, charts, graphs, tables, and profiles are constructed and interpreted.

2 **Sci4.6:** The student will investigate and understand how weather conditions and phenomena occur and can be predicted.

3 **Sci6.5:** The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment.

Vocabulary:

accretion
aggregation
latitude
longitude
precipitation
snow and ice
sublimation
temperature
water vapor

Lesson Links:

Overview of Winter Precipitation Types
Applet to Grow Snowflakes
Live Access Server

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Background:

Snow and ice are both precipitation, that is, the processes that remove water from clouds. Clouds, regions of the atmosphere with high relative humidity, are made of droplets of water and perhaps bits of ice. Even though water is much denser than air, these droplets and ice crystals are small enough to be suspended by random upward air motion. When these droplets or crystals join together, gravity overcomes the suspending force and we have precipitation.

Cloud temperature, which varies within a cloud, affects the crystal shape of snowflakes. For instance, large, dendritic flakes grow best at temperatures of -10 to -12 degrees Celsius, while plates grow at warmer and colder conditions. If the flake passes through dry air, it may sublimate. If other ice crystals are present, they may aggregate onto the crystal. If liquid water is present, it may accrete. All these processes can alter snowflakes shapes.

In this lesson, you will investigate NASA satellite data to determine geographical areas where wintry precipitation may have occurred based on cloud top temperature. You will use tables of snowflake formation versus temperature to determine what shapes of crystals likely occurred.

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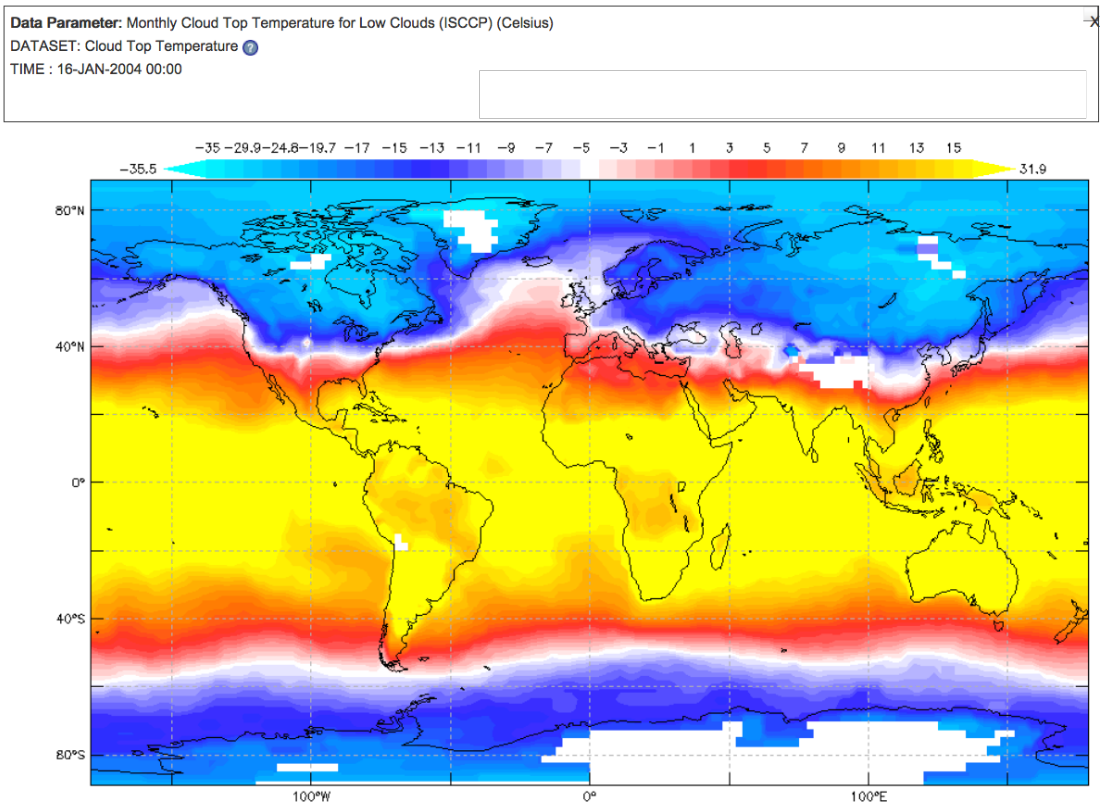
Procedure:

Part 1: Use the following 2 maps and additional information to answer the questions and to pick a city to investigate in Part 2.

Plot 1 –Monthly Cloud Top Temperature for Low Clouds from ISCPP (degrees Celsius) in January 2004.



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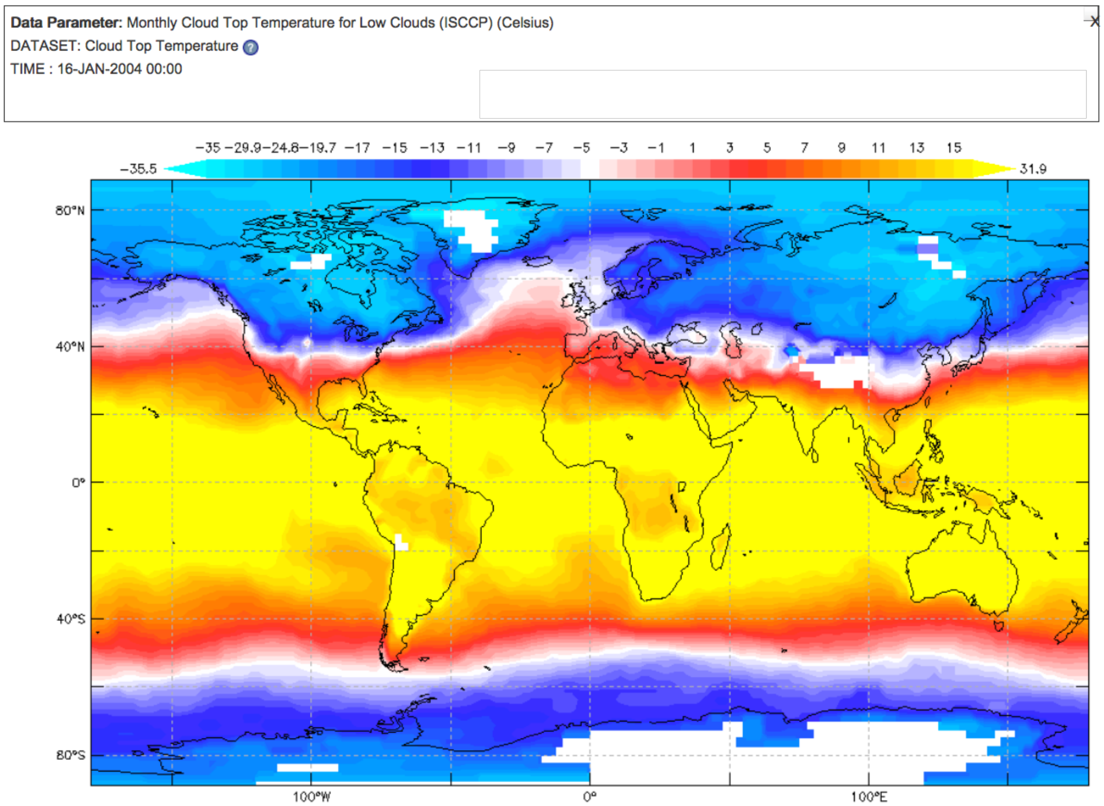
Plot 2 –Monthly Precipitation from GPCP (mm/day) in January 2004.



Part 1 Questions and Instructions:

Using the two plots above, discuss with your class what areas you think would have snow in January.

Using your answers to Question 1, select one of the following cities and find its location on a map. There are 6 cities to choose from, so students may want to work in small groups and investigate each city:

City Name: Buffalo, New York
Country: United States
Latitude: 42.886447
Longitude: -78.878369

City Name: Indianapolis, Indiana
Country: United States
Latitude: 39.785853
Longitude: -86.156783

City Name: Vancouver, British Columbia
Country: Canada
Latitude: 49.282729
Longitude: -123.120738

City Name: London
Country: England/United Kingdom
Latitude: 51.529069
Longitude: -0.13593

City Name: Moscow
Country: Russia
Latitude: 55.755826
Longitude: 37.617300

City Name: Oslo
Country: Norway
Latitude: 59.913869
Longitude: 10.752245

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1. For your chosen city, use Plot 1 above to estimate the cloud top temperature in January.

2. For your chosen city, use Plot 2 above to estimate the annual precipitation for your city. Use the formula **mm per day X 14.4 = inches per year.**

3. Do a search on the internet to find a picture of the city as well as the following information: language spoken, population, and elevation.

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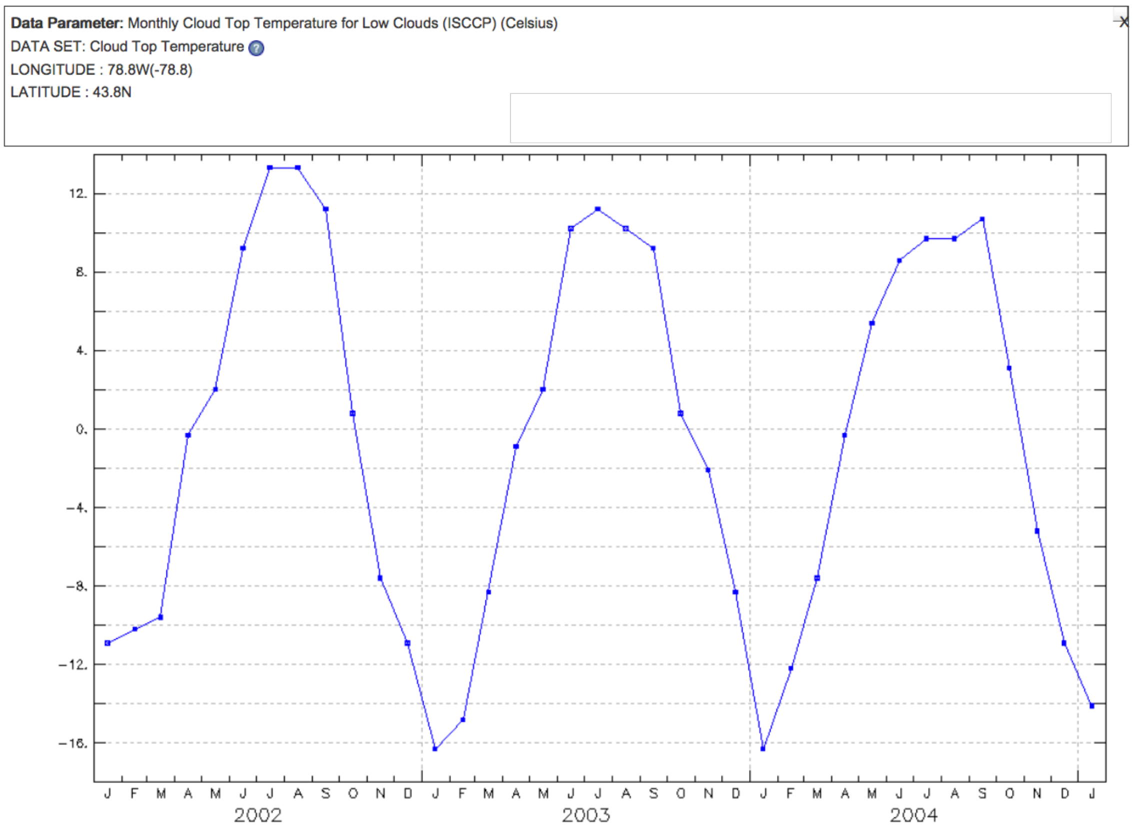
Part 2: Find your selected city in the next set of plots, then use the time series graphs of monthly cloud top temperature and precipitable water to answer the questions starting on page 21.

City Name: Buffalo, New York

Plot 1 –Monthly Cloud Top Temperature for Low Clouds from ISCPP (degrees Celsius), January 2002 – January 2005.



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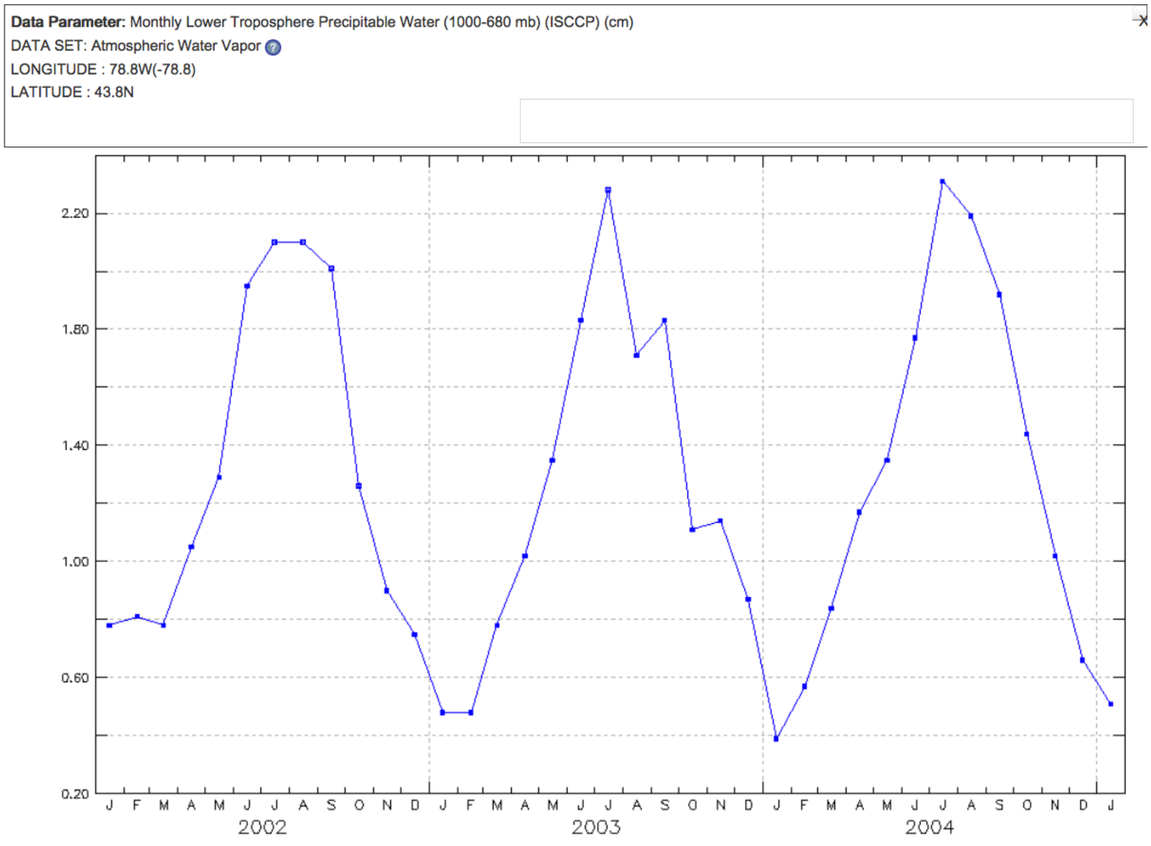
Plot 2 –Monthly Lower Troposphere Precipitable Water (1000-680 mb) from ISCPP (cm), January 2002 – January 2005.



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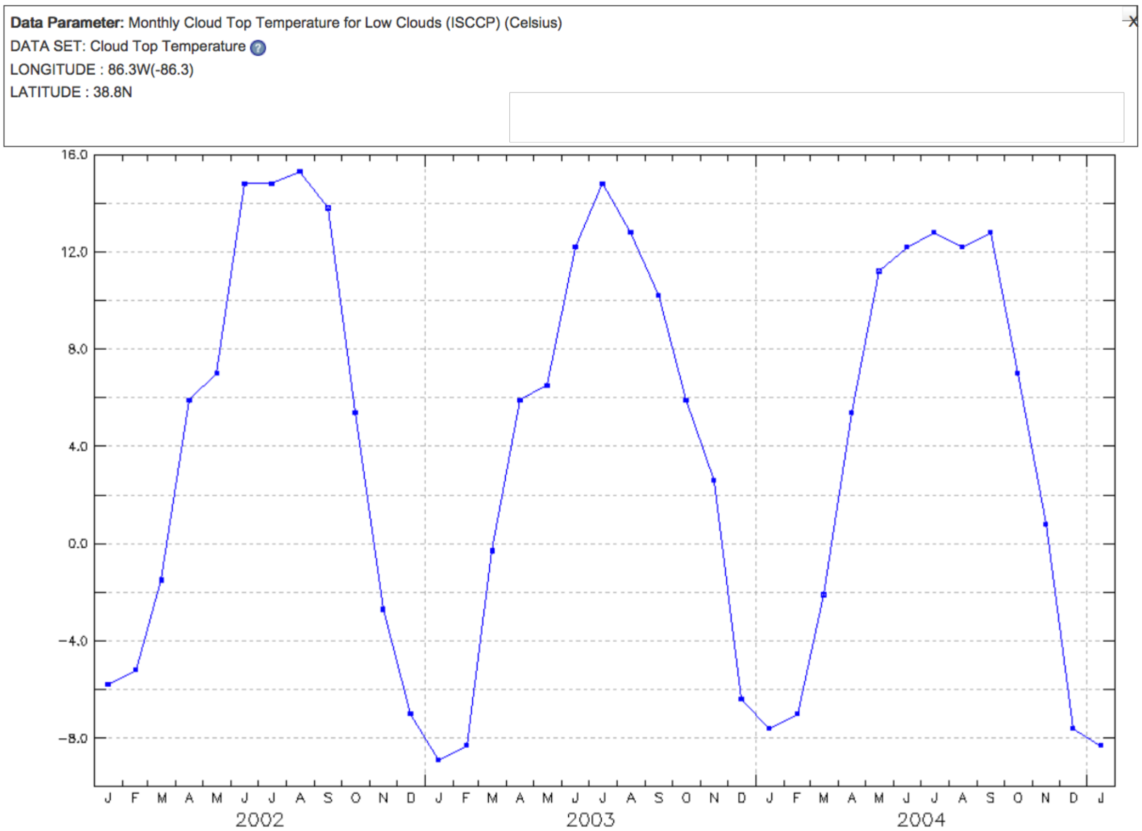
City Name: Indianapolis, Indiana

Plot 1 –Monthly Cloud Top Temperature for Low Clouds from ISCPP (degrees Celsius), January 2002 – January 2005.



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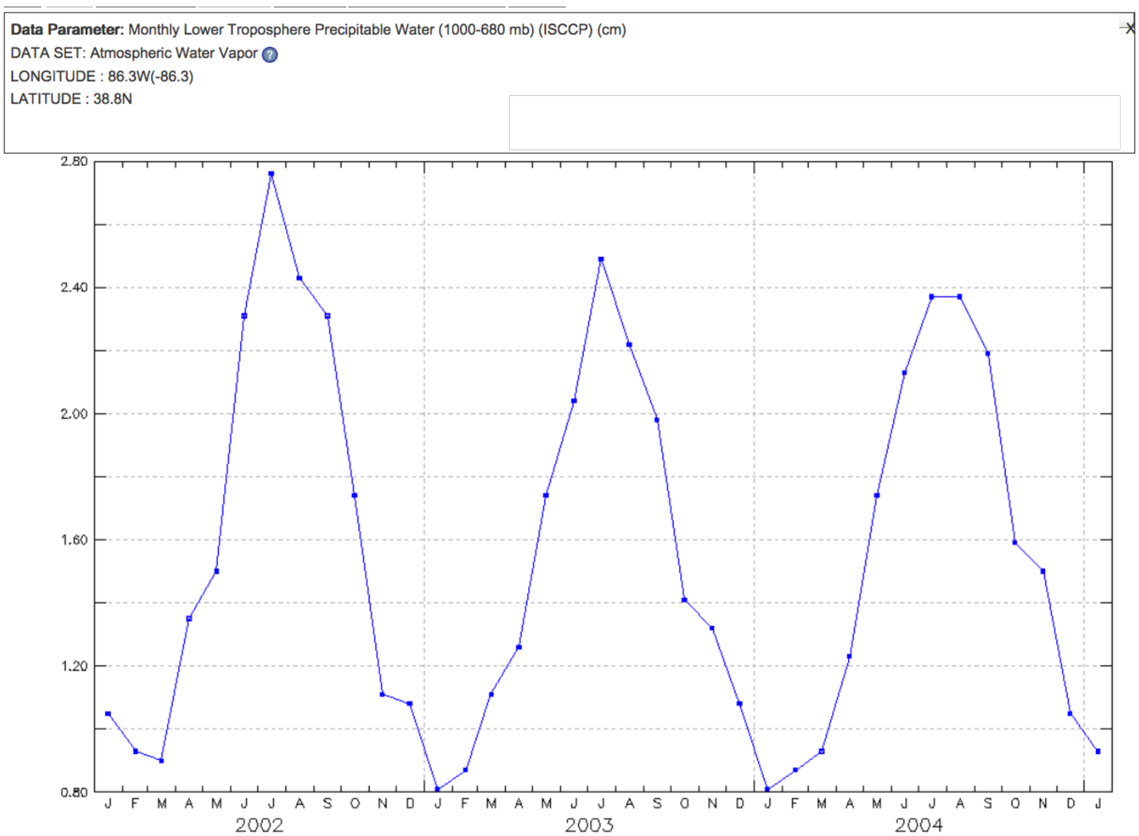

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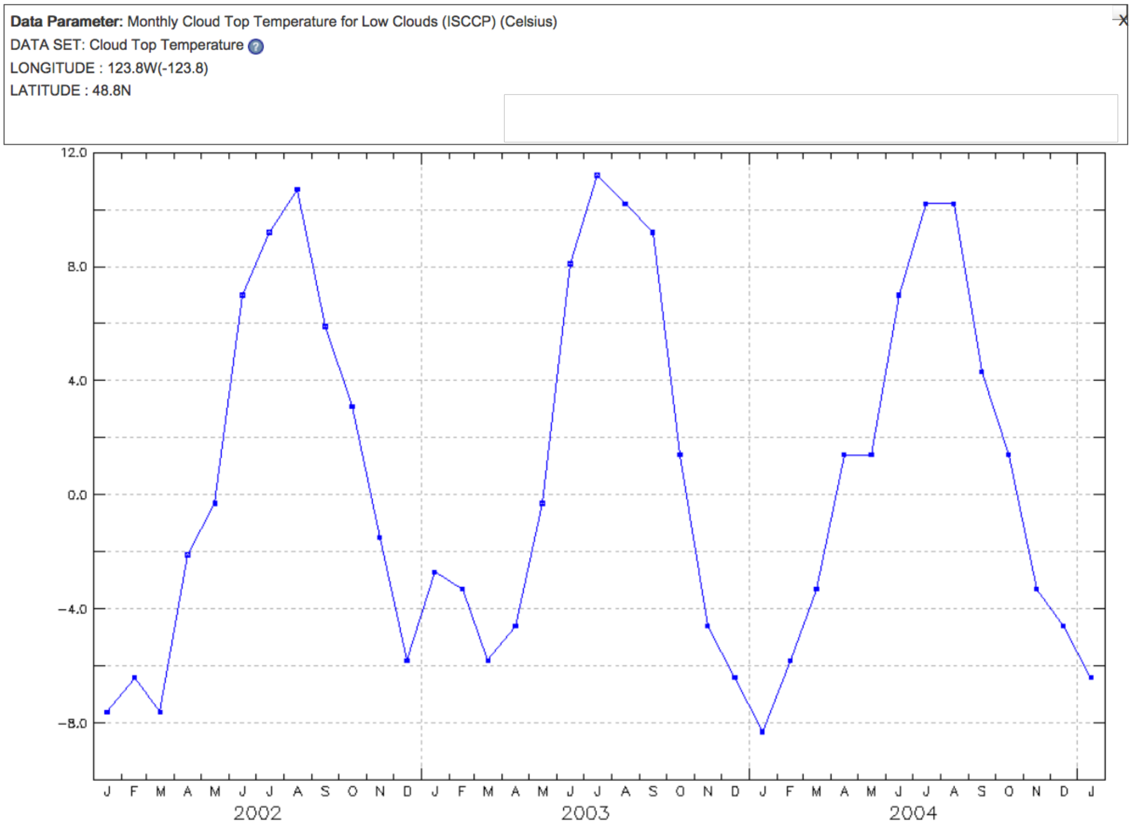
City Name: Vancouver, British Columbia, Canada

Plot 1 –Monthly Cloud Top Temperature for Low Clouds from ISCPP (degrees Celsius), January 2002 – January 2005.



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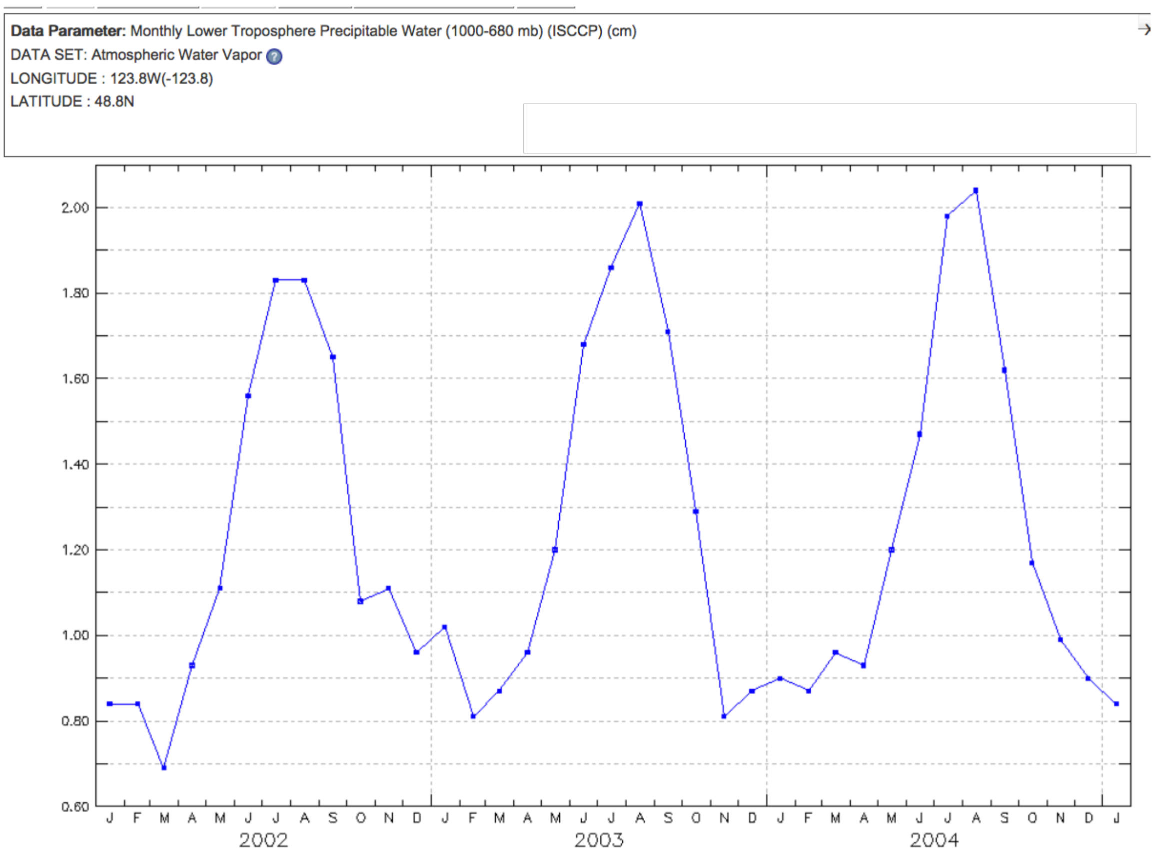

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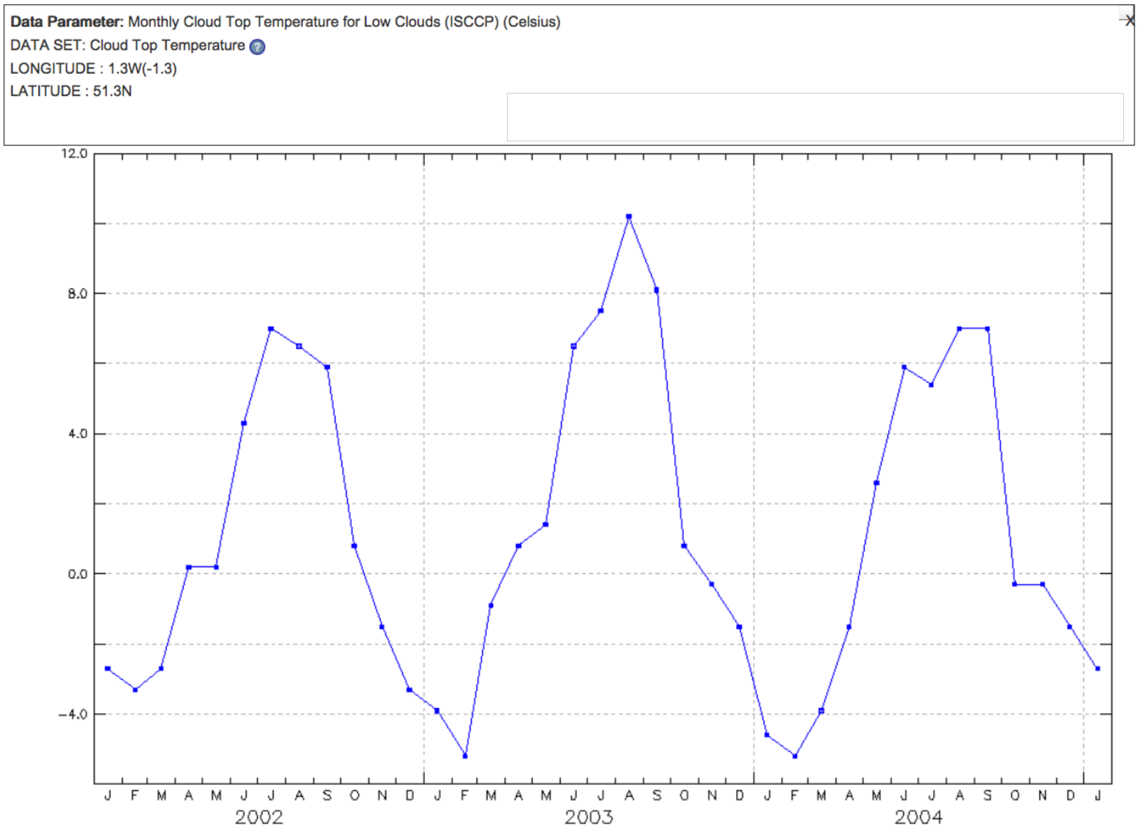
City Name: London, England, United Kingdom

Plot 1 –Monthly Cloud Top Temperature for Low Clouds from ISCPP (degrees Celsius), January 2002 – January 2005.



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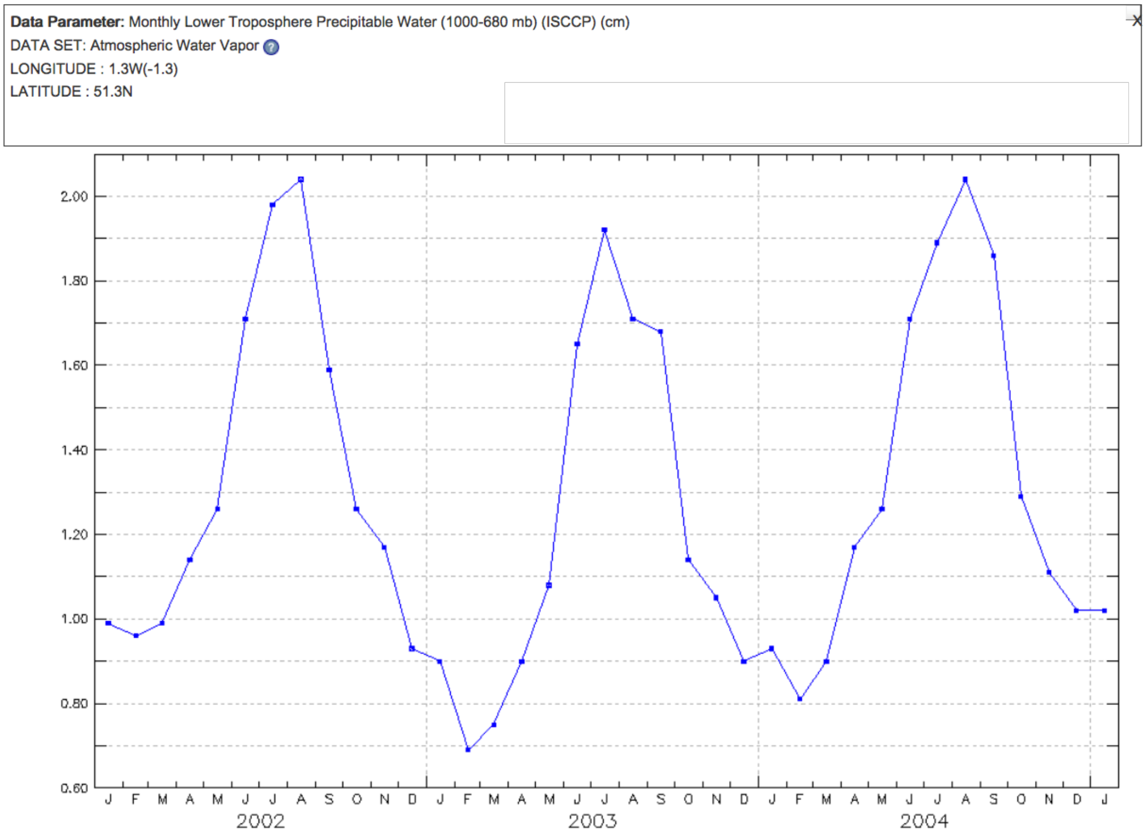

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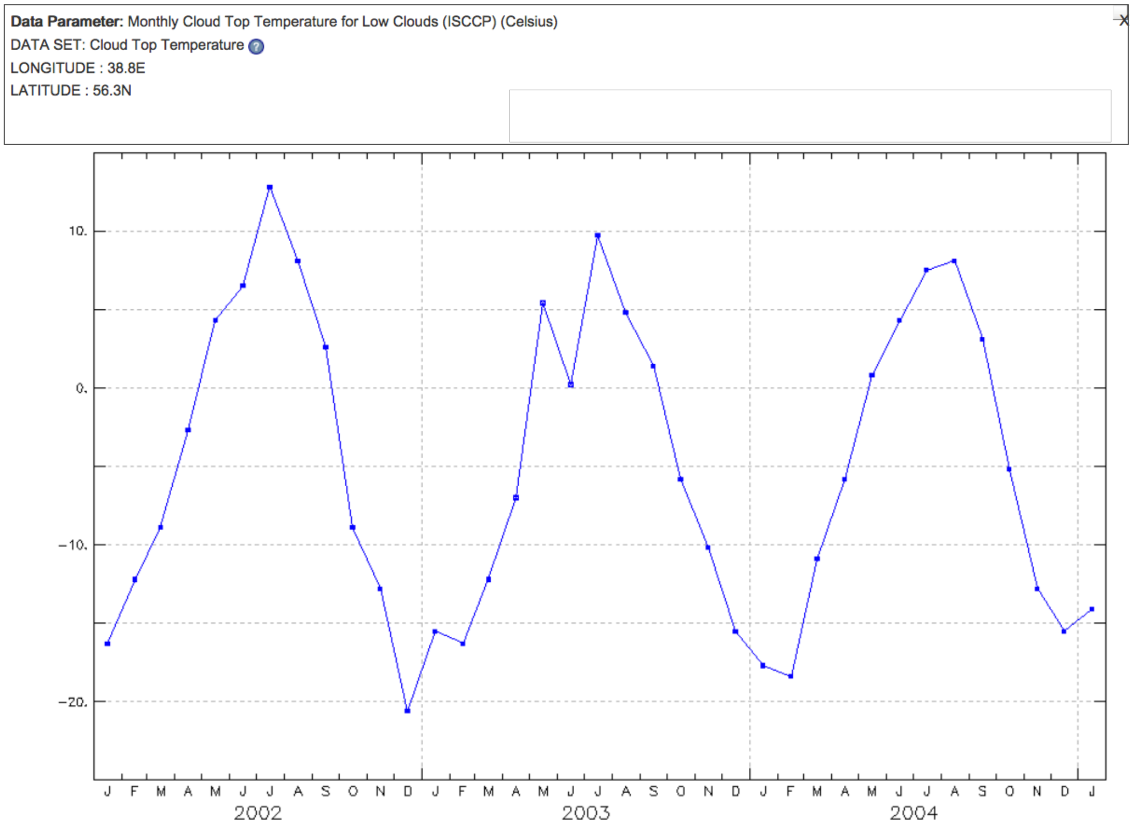
City Name: Moscow, Russia

Plot 1 –Monthly Cloud Top Temperature for Low Clouds from ISCPP (degrees Celsius), January 2002 – January 2005.



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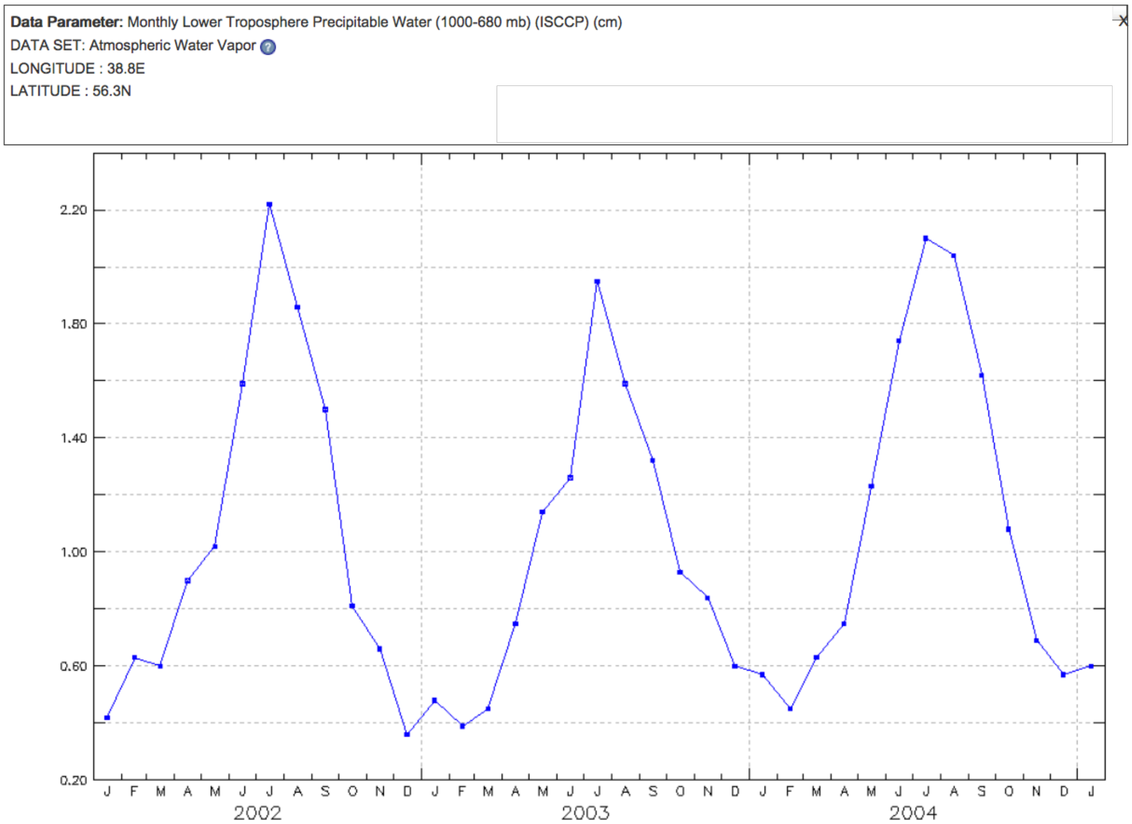

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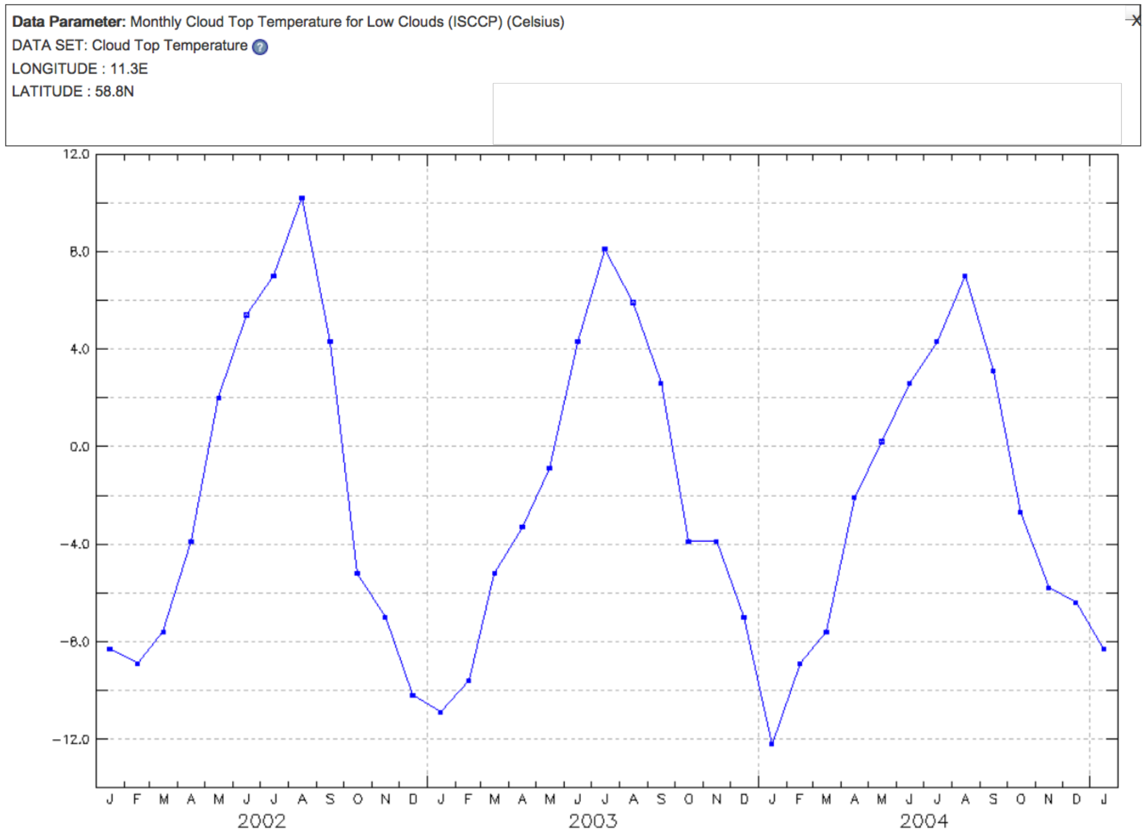
City Name: Oslo, Norway

Plot 1 –Monthly Cloud Top Temperature for Low Clouds from ISCPP (degrees Celsius), January 2002 – January 2005.



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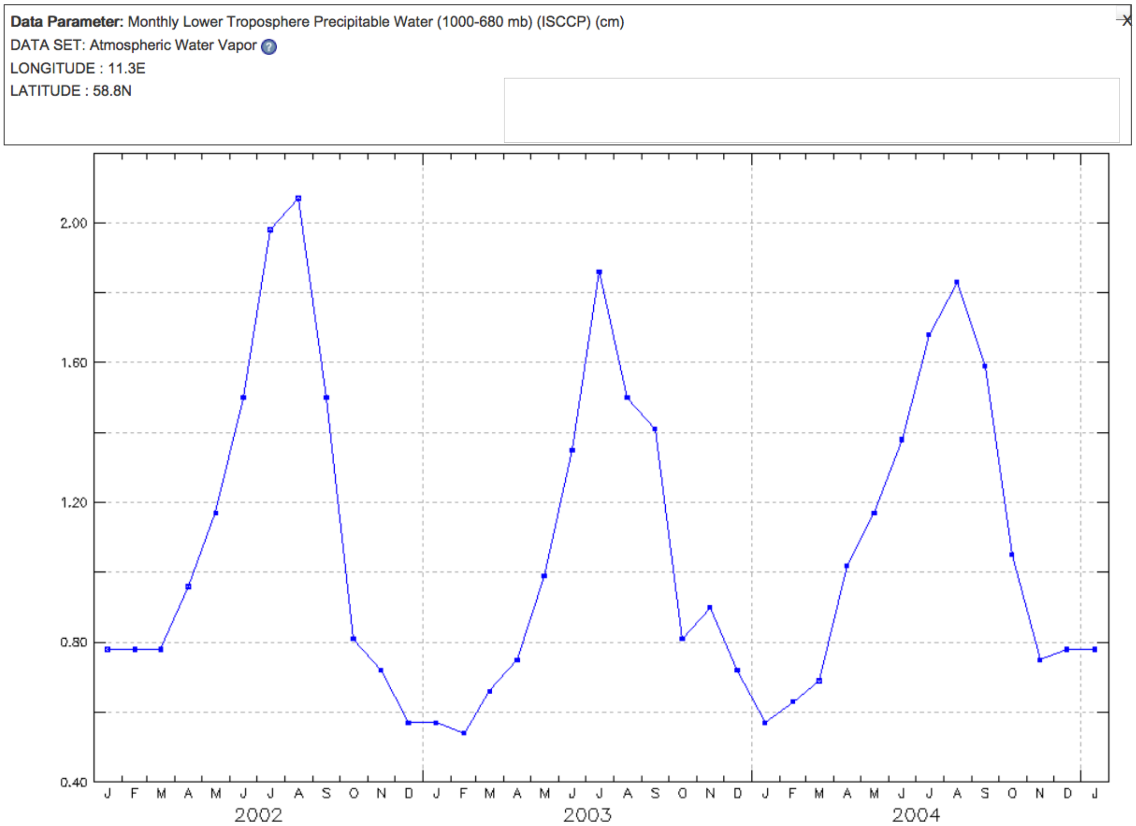

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Part 2 Questions:

1. How are the graphs of all of the cities the same? How are they different?

2. During what months are the temperatures of the cloud tops the warmest? During what months are they coldest?

3. During what months does the lower atmosphere have the highest amount of moisture? During what months does it have the lowest amount of moisture?

4. When the atmosphere has low moisture, what seems to be true of the temperature of the cloud tops? When the atmosphere has high moisture, what seems to be true of the temperatures of the cloud tops?

5. How does the temperature of the tops of the clouds relate to the amount of moisture in the atmosphere?

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Part 3: Determine the Celsius temperature of your city from the LAS map. Use the Applet to Grow Snowflakes - http://whyfiles.org/interactives/a4.html - to create an image of what a snowflake would look like in that area of the world with that cloud top temperature. Next, use the print screen, copy, and paste functions to paste that image into a word document.

Part 3 Questions:

Answer the following questions based on your snowflake:

1. Are the shapes of the snowflakes all the same? What makes the shapes different?

2. What types of symmetry do the snowflakes with dendrites and plates have?

3. How many lines of symmetry are there?

4. What is the angle of rotational symmetry?

5.
Determine the number of faces, edges, and vertices of the prisms and columns.
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Extensions:

1. Collect the elevation and annual precipitation from all of the cities and chart them on a scatter plot in Excel to see if there is a relationship.

2. Collect annual precipitation and north latitude from all of the cities and chart them on a scatter plot in Excel to see if there is a relationship.

3. On snowy days, collect snowflakes on cold, black paper. Examine them with hand lenses to determine what their structure is. Use NOAA or National Weather Service sites to find out what the cloud temperature was as well as the amount of water vapor.

4. Generate a 3rd map of near surface temperature and see how well it matches with the map of low cloud top temperature